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a report on the VALUE OF WILDLIFE with 1979 addendum

A REPORT ON THE VALUE OF WILDLIFE
(Wildlife Economics)

Prepared for the

INTERMOUNTAIN REGION
Forest Service
by

Christopher S. Hansen

DECEMBER 1, 1977

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by

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SUMMARY

Economic value figures are derived for the fish and wildlife resources on National Forest lands in the Intermountain Region. The measure of value employed in the study is total willingness to pay for days of wildlife use or wildlife-oriented recreation. Existing data are used. The economic values are summarized according to major species groupings or categories of use (big game hunting, waterfowl hunting, cold water sport fishing, etc.) by State and for the Region as a whole. The total value of the fish and wildlife resources for the Region in 1976 was about $110 million, based on levels of use and daily valuations for that year. Qualifications are placed on the meaning and potential uses of the results of this study. Problems associated with the selection of an appropriate methodology and implications of that choice for study results are discussed.

A process is outlined for valuing habitat improvement work done for wildlife. Because of a lack of quantitative knowledge of the relationships involved and a dearth of relevant data, very tenuous assumptions are required to derive an economic value of improved habitat. Two possible values are derived for an acre of improved mule deer habitat, but it would be necessary to use site-specific information to evaluate a particular habitat improvement project.

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INTRODUCTION

The purpose of this report is to provide an economic value for the fish and wildlife resources on National Forest lands in the Intermountain Region. Because of the time and financial constraints, it was not possible to conduct new data surveys. Such surveys would provide data specific to the Intermountain Region and would provide information which would more closely fit a chosen evaluation methodology. Instead, it was necessary to use existing methodologies and data such as they are to construct the values given in this report.

After a brief description of the Intermountain Region and its fish and wildlife resources, note is made of the variety of methodologies that have been used in the field. Next, basic choices that must be made when adopting an economic valuation methodology are briefly discussed, and the methodology chosen for this report is outlined. This approach is then combined with existing figures to give economic values for the Intermountain Region's fish and wildlife resources. The value figures are summarized by major groupings (big game, upland game, etc.) for each State within the Region and for the Region as a whole.

Finally, an attempt is made with the help of various assumptions to place a value on improved mule deer habitat. The process for valuing improved habitat is outlined, and the value of improved habitat is calculated on a per acre basis. This figure may be used, with modifications for local or regional conditions, to calculate the value of habitat improvement work done in the Region.

The Intermountain Region includes all National Forest lands in Utah, Nevada, southern Idaho (roughly 60%), Wyoming west of the continental divide, a few thousand acres in western Colorado, and a small section of eastern California running north and south from Lake Tahoe. The Region is the largest in the Forest Service, comprising 31.14 million acres of National Forest lands. This area is divided among the States as Follows:

IDAHO	*13.51 million acres*
UTAH	*8.05 million acres*
NEVADA	*5.05 million acres*
WYOMING	*3.87 million acres*
CALIFORNIA	*0.63 million acres*
COLORADO	*0.03 million acres*

The area ranges from alpine to desert ecotypes. It supports many wildlife populations and contains many fisheries. The Intermountain Region ranks first or second among all Forest Service regions in total mule deer, mountain lion, antelope, bighorn sheep, and moose populations. It ranks third or fourth in size of several other big game populations that it supports. Upland game populations, particularly forest grouse, are significant in the Region, as are small game populations. Because of the general nature of National Forest land, waterfowl habitat and habitat types supporting upland game birds other than forest grouse are not prevalent. The Region contains over 12,000 miles of cold water fishing streams on National Forest land, including more than 1,000 miles of anadromous fish waters.

Although the Intermountain Region supports numerous wildlife populations, in comparison to other Forest Service regions, the human use of those terrestrial resources is much lower in ranking -- generally 6th or 7th. Fishing use is high, though, ranking 2nd in 1976. The level of use of terrestrial wildlife is primarily an indication of the relatively sparse human population in the Intermountain area as compared to other parts of the country. The fisheries use probably indicates the high quality and quantity of cold water fishing streams and lakes.

concerning use by or expenditures of non-resident fish and wildlife recreationists. These data were presented for resident users who leave the State to hunt or fish. But they were not given for non-residents coming in from outside the state to hunt or fish. Since expenditures and willingness to pay values were included for resident hunters and anglers, as well as for residents leaving the state to hunt and fish, it was assumed for the purposes of this study that the average value per recreation day derived from these figures would be comparable to one that would be derived which excluded residents going out-of-state and included non-residents coming into the state. The total values derived will be somewhat over or understated if the net effect of residents going out-of-state versus nonresidents coming into the state is larger or smaller than the zero net effect assumed.

One other potential problem with the use of the 1975 Survey data was its reliability. Because the samples were relatively small, variances were quite large, particularly in the smaller categorical breakdowns. The true average daily values may lie within quite a wide confidence interval. Since average values are used to derive the total values, their accuracy can have a significant effect on the total valuation obtained for the various States and for the Region. Reliability may be checked very roughly by comparing just expenditure data for the Wyoming State Technical Report with another 1975 expenditures survey for Wyoming recently released (Phillips and Ferguson, 1977). The expenditures reported in the 1975 Survey are roughly comparable with those reported by Phillips and Ferguson, indicating that the former appears to be well within reasonable bounds. (A direct comparison cannot be made, because the 1975 Survey shows expenditures of all hunters and anglers living within the State, no matter where they hunt or fish in the United States. The Phillips and Ferguson study lists expenditures according to those made by resident and non-resident hunters and anglers within Wyoming.)

TABLE 1

WILDLIFE USER DAY UNIT VALUES
(Dollars)

	IDAHO	NEVADA	UTAH	WYOMING	REGION 4 (Weighted Avgs.)
Big Game Hunting	31.84	68.25	47.44	35.34	39.44
Deer	22.94	72.88	41.87	26.78	
Elk	40.64	19.32	78.95	42.18	
Antelope	19.60	37.33	0.00	13.26	
Other Big Game	42.62	145.00	206.30	64.79	
Small Game Hunting	22.31*	29.31	47.71	14.52	28.81
Upland Bird Hunting	35.36	73.83	25.33	50.00	38.96
Waterfowl Hunting	14.44	48.49	30.95	67.15	29.53
Cold Water Sport Fishing (non-anadromous)	15.15	25.41	21.23	16.32	19.20
Anadromous (sea-run) Sport Fishing	28.20	.....	.....	.....	28.20
Non-Consumptive Use (observ. expend. only)	1.40	0.71	1.68	1.00	1.26

*Adjusted to eliminate one extrememly high response.

(Source: Derived from the State Technical Reports, 1975 National Survey of Hunting, Fishing and Wildlife-Associated Recreation, USFWS, 1977.)

To provide a check on the figures shown in Table 1, several other studies which have placed values on wildlife or wildlife activities were examined along with the 1975 Survey. These included studies made in the Southeast U.S. (Environmental Research Group, 1974); Arizona (Martin, et al., 1974); Colorado (Ashton, et al., 1974; and Norman, et al., 1976); Oregon (Brown, et al., 1973); Idaho (Gordon, et al., 1973); and the values used for the RPA 1975 Assessment (USDA Forest Service, 1975). After manipulating these various value figures to some degree in order to get them all in terms of 1975 constant dollars and to mold them somewhat to fit the wildlife user day measure, a rough composite average value figure was derived for each of the major wildlife use categories (Table 2). These values, which can be used as Region-wide total willingness to pay figures for wildlife user days, are quite close to the weighted Regional averages shown in Table 1.

TABLE 2
COMPOSITE WILDLIFE USER DAY VALUES
(Dollars)

ACTIVITY	AVERAGE USER DAY VALUE
Big Game Hunting	40
Small Game Hunting	25
Upland Bird Hunting	35
Waterfowl Hunting	30
Cold Water Sport Fishing (non-anadromous)	20
Anadromous (sea-run) Sport Fishing	30
Non-Consumptive Use	40

Wildlife User Days

All of the reports mentioned in the previous section included various estimations and surveys of visitor or user days. But none provides a breakdown of user days by National Forest lands. Therefore, the wildlife user days on National Forest lands were derived for 1976 from the Recreation Information Management System (RIM) reports for the Intermountain Region. These recreation days are only given for major species groupings, big game hunting, small game hunting, etc. No breakdown exists in the RIM system to identify wildlife-oriented non-consumptive recreation activities. Therefore, only those RVD's reported for "Nature Study" were used. (There are other possibilities, such as "Walks and Hikes," but there is no way to make any reasonable breakdown. As it is, the "Nature Study" category may include days of non-zoological study.)

The total wildlife use days are shown by category on Table 3 for the States and the Region. It should be noted that these are standardized 12-hour recreation visitor days. Thus, three 4-hour rabbit hunting trips would show as one 12-hour recreation visitor day under 'Small Game Hunting."

TABLE 3
WILDLIFE USER DAYS ON NATIONAL FOREST LANDS, 1976
(12-hour Recreation Visitor Days)

	IDAHO	NEVADA	UTAH	WYOMING	REGION 4 (Total)
Big Game Hunting	306,800	131,200	609,300	161,700	1,209,000
Small Game Hunting	14,700	11,300	34,900	3,100	64,000
Upland Bird Hunting	29,700	24,200	43,300	5,500	102,700
Waterfowl Hunting	12,900	11,900	28,300	5,200	58,300
Cold Water Sport Fishing (non-anadromous)	623,200	429,800	1,049,600	261,800	2,364,400
Anadromous (sea-run) Sport Fishing	19,200*	----------	----------	----------	19,200
Non-Consumptive Use ("Nature Study")	21,100	13,400	43,500	14,700	92,700

*Anadromous fishing days dropped from about 10% of total cold water sport fishing days in 1968, to about 3% in 1975 because of low andromous fish runs and closed seasons.

(Source: U. S. Forest Service RIM Reports, 1976)

Value of Improved Habitat

Because of the extreme paucity of data on any habitat-population production relationship, only mule deer habitat is dealt with in this report. Ideally, the value of improved deer habitat would be relatively easy to measure. Given a certain habitat treatment, the appropriate vegetation response in quantity and quality terms, and the response of deer productivity (increased natality and fawn survival) to the increased quality and quantity of vegetation; one would only need the ratio of hunter day use per deer to derive the total additional hunter days that would be supported by the additional deer produced on the improved habitat. Multiplying the additional hunter days which the improved habitat supported by the hunter day value would give the incremental value (in terms of human use) of the improved habitat per unit area.

Unfortunately, the current state of the art and a lack of data allow very little of the above process to be carried out. First, measurements are just beginning to be made of vegetation responses to various types of habitat treatment. Not only is it necessary to know how much additional biomass is produced by weight; it is also necessary to know the caloric and nutritional content of the incremental production. Only a few site-specific studies have measured the quantity (biomass) response to habitat improvement techniques, and fewer yet have analyzed the quality of the responding vegetation. Finally, in this same vein, the vegetation response induced by habitat manipulation must be edible by deer. If inedible or unpalatable species are part of the net increase in vegetation, the improved habitat will be of less value to deer production by that extent.

The second major problem is that no production functions for deer have yet been derived. In other words, it is not yet possible to say that, given a certain increase in quantity and/or quality of forage on a certain area, there will be an increase of so many animals produced on that area.

There is currently no direct quantitative relationship known between habitat inputs on the one hand and deer production on the other.

Third, average figures for an entire state for hunter day use per deer is a very poor substitute for site-specific data. For instance, improving habitat and increasing the deer herd in one area might draw a much larger hunting response than would the same project on another area, simply because of the relative proximity of human populations, the ease of access to the area, and so on. To use figures based on state-wide averages for analysis of a specific habitat improvement project would result in poor projections of the relative value of that project compared to others. Under these circumstances, hunter day use per deer figures should be adjusted to reflect site-specific circumstances.

Finally, it is questionable whether numbers of hunters and hunter days in the field respond directly to the size of the deer population. Research in Michigan (Hansen, 1977) showed that change in the deer population size explained by itself very little of the change in numbers of hunters in the field. Only when combined with such factors as the State's human population and the previous year's deer harvest did the size of the deer herd begin to have a significant explanatory effect on the number of hunters in the field. It may not be accurate to assume that there will be a corresponding increase in hunter days as improved habitat leads to increased deer populations.

Operating with the belief that a first approximation is still better than a general guess, it is possible to make some heroic assumptions (in light of the preceding discussion) and to lay out a process by which habitat improvements for deer could be valued. These assumptions are:

1. Knowledge of quantitative net production of vegetation after habitat manipulation is by itself sufficient to determine the response of deer to the improved habitat.
2. Deer, on the average, eat five pounds of food per day.
3. All net forage production goes to the production of additional deer. None is used by deer in the surrounding areas moving in to eat the new vegetation, by livestock, or by other animals.
4. There is a direct relationship between the number of deer in an area and the number of hunter days spent in the area.

If these assumptions are made, an estimate can be made of the value per acre of improved deer habitat. As the linkages in the system are refined, and as data and known relationships can be substituted for assumptions, the estimates can be vastly improved.

Winter range is limiting to deer populations in almost all parts of the Intermountain Region. Therefore, most habitat improvement is carried out on winter range. An estimate of the value of improving this range can be made as follows:

1. Divide net (incremental) pounds of forage production per acre by five (the amount eaten by a deer per day) to derive the number of deer-days per acre the additional vegetation can support.
2. Assume the winter season is five months, or 150 days, long. Then 150 deer-days of forage are required to get one deer through the winter.
3. The ratio of the number of deer-days that can be supported per acre of improved habitat to the deer-days required to get through the winter season gives the additional deer that can be supported through the winter on an acre of improved habitat.

4. Derive a ratio of hunter days to deer population for a known area, such as the State or a localized region.
5. Multiply the number of hunter days supported by one deer times the additional deer per acre of improved habitat to get the additional hunter days supported by an acre of improved habitat.
6. Multiply these hunter days by the appropriate daily value for deer or big game hunting. This gives the economic value (in terms of human use) of the acre of improved habitat.

It must be reiterated that this method involves heroic assumptions and should be used with great care and acknowledgement of the assumptions involved. It should also be noted that this method does not account for a possible decrease in value of hunter days because of increased hunter congestion and decreased hunting quality.

RESULTS

Total wildlife economic values for the Intermountain Region were obtained by multiplying the wildlife user days on National Forest lands in the Region (Table 3) by the appropriate value per day (Table 1). The results, by State and for the Region, are shown in Table 4. The results are the economic values, as measured by total willingness to pay, for wildlife-related recreation days partaken in the Region during 1976. This set of values is based on the 1975 Survey figures, with one exception. Since the daily value for non-consumptive use was so restrictive, the standardized value from Table 2 was used for non-consumptive wildlife recreation days.

Table 5 gives the total wildlife economic values for the Region using the composite daily values given in Table 2 for all of the wildlife user days in the Region. The totals are very close in magnitude to those derived from the more individualized State values used for Table 4.

TABLE 4
TOTAL ECONOMIC VALUE OF WILDLIFE RESOURCES
ON NATIONAL FOREST LANDS USING STATE-SPECIFIC VALUES ($1,000's)

	IDAHO	NEVADA	UTAH	WYOMING	REGION 4 (Total)
Big Game Hunting	9,769	8,954	28,905	5,714	53,342
Small Game Hunting	328	331	1,665	45	2,369
Upland Bird Hunting	1,050	1,787	1,097	275	4,209
Waterfowl Hunting	186	577	876	349	1,988
TOTAL, ALL HUNTING	11,333	11,649	32,543	6,383	61,908
Cold Water Sport Fishing (non-anadromous)	9,441	10,921	22,283	4,273	46,918
Anadromous (sea-run) Sport Fishing	541	----------	----------	----------	541
TOTAL, COLD WATER FISHING	9,982	10,921	22,283	4,273	47,459
TOTAL, HUNTING & FISHING	21,315	22,570	54,826	10,656	109,367
Non-Consumptive Use (composite daily value)	844	536	1,396	124	2,900
TOTAL WILDLIFE VALUE	22,159	23,106	56,222	10,780	112,267

Habitat Improvement Value

An economic value was derived for an acre of improved mule deer habitat, under the assumptions described in the methodological section. The figure was derived as described earlier, using a figure of 1,000 pounds of additional forage production per acre after a burn (Davis, 1977), and using information from the 1975 Survey and the Forest Service RIM reports to derive a ratio of deer hunter days on Utah National Forest lands to the deer population on Utah National Forest lands. This ratio came out to be 3.5 hunter days per deer. Given an estimated 50 percent utilization rate of the net forage production, 100 deer-days could be supported per acre of winter range, or 0.67 deer per acre for the winter season. For each acre, 0.67 deer would support an additional 2.3 hunter days per year. Using the composite value of $40 per big game hunting day, the economic value of the improved habitat in terms of human wildlife-oriented recreation use would be $92 per acre per year.

TABLE 5

TOTAL ECONOMIC VALUE OF WILDLIFE RESOURCES
ON NATIONAL FOREST LANDS USING COMPOSITE AVERAGE VALUES ($1,000)

	IDAHO	NEVADA	UTAH	WYOMING	REGION 4 (Total)
Big Game Hunting	12,272	5,248	24,372	6,468	48,360
Small Game Hunting	368	283	873	78	1,602
Upland Bird Hunting	1,040	847	1,516	193	3,596
Waterfowl Hunting	387	357	849	156	1,749
TOTAL - ALL HUNTING	14,067	6,735	27,610	6,895	55,307
Cold Water Sport Fishing (non-anadromous)	12,464	8,596	20,992	5,236	47,288
Anadromous (sea-run) Sport Fishing	576	----------	----------	----------	576
TOTAL - COLD WATER FISHING	13,040	8,596	20,992	5,236	47,864
TOTAL - HUNTING & FISHING	27,107	15,331	48,602	12,131	103,171
Non-Consumptive Use	844	536	1,396	124	2,900
TOTAL WILDLIFE VALUE	27,951	15,867	49,998	12,255	106,071

The value figure for improved habitat is quite sensitive to changes in the variables involved. Assume, for instance, that Davis' (1977) net forage production is substantially high for typical winter range. Perhaps the net forage production figure should only be 500 pounds per acre. Assume, too, that forage available for new deer is less than fifty percent because of increased utilization by existing deer, some influx of deer from outside the area, and a relatively low response of palatable species. If one uses a twenty-five percent utilization figure, along with 500 pounds of net forage production, the total deer days supportable on an acre of winter range drops to 25, and the number of additional deer that can conceivably be supported drops to 0.17 per acre. The economic value of that improved habitat based on the hunter days to deer ratio given above, would now be only $24 per acre.

DISCUSSION

The total willingness to pay for the human use of fish and wildlife resources in the Intermountain Region in 1976 was in the neighborhood of $100,000,000. Although this is definitely a first approximation of the actual value-in-use of these fish and wildlife resources, there is nothing to indicate that the order of magnitude of these figures is in error. In fact, the figures may be somewhat conservative. The Colorado Division of Wildlife uses a value figure of $709 for each deer harvested in the State as representative of the total value of the State's deer population. If this figure were used for the Intermountain Region, total value of deer hunting alone in 1976 would have been $40,882,358 (57,662 deer harvested times $709 per deer harvested). This is nearly as much as the total economic value shown for all big game hunting in the Region (Table 4).

The results of this report show the total value-in-use to humans of the fish and wildlife populations of the Region. This includes both expenditures incurred and consumer's surplus enjoyed in partaking of the total wildlife recreation or use experience. The value of the unique contributions made by the fish and wildlife resources to the total wildlife recreation experience could probably be better measured by some portion of consumer's surplus. However, for reasons discussed in the appendix, it was felt that total willingness to pay would be a more usable and comparable measure of the value of the wildlife resources in the National Forest system than would some measure of consumer's surplus alone.

It must be pointed out that these values and days of use do not represent "demand" in the economist's jargon. Rather, they represent a current level of use in conjunction with a current daily valuation. It is very risky to make future projections from these figures of daily or total values and of total use of the resources. Any number of variables may change which would alter the expense of participating in a wildlife use day, the supply of fish or wildlife, or the desires of people to engage in such activities. If any of these factors change, the level of use and the total valuation of the resources may go up or down.

The results shown here are highly aggregated. In reality, levels of use and values-in-use are highly site-specific. The use of broad average values as done here blankets over a multitude of localized variations. This must be remembered when projects or programs are being analyzed on a local basis.

The values given in this study measure total value-in-use. As such, they should not really be used to calculate marginal values of proposed programs, except where very "lumpy" tradeoffs between alternative projects are involved. It must be remembered that the daily RVD values are averages over all total willingness to pay for use of the resource. The actual value of the last additional RVD produced by a project will probably not be as high as the average values used here. Such marginal values would have to be determined on a species-, site-, and project-specific basis.

The many problems encountered in trying to establish a value for improved habitat were discussed in the methodological section. Because of the sensitivity of the results to changes in the relevant variables, extreme caution should be used in applying a single value across the Region. The process shown may be used to establish a "ballpark" value for an acre of improved habitat, but the figures should be refined according to the expected vegetation response at the site, the probable utilization factor, the pattern of wildlife use in the area, and the regional or local ratio of hunter days to deer. The estimate of 3.5 hunter days per deer was

used for National Forest lands in Utah, but that estimate changes to 1.9 hunter days per deer in Nevada and to 1.3 hunter days per deer in Idaho. These lower figures will lower the estimated value of improved habitat significantly.

A final problem encountered that could affect the whole valuation of the fish and wildlife resources is the manner in which recreation days are reported. All of the studies from which value figures were taken, including the 1975 Survey, reported a wildlife user day as any portion of a day spent pursuing some wildlife-related activity. By contrast, the Forest Service user days are reported as 12-hour days. To the extent that expenditures and willingness to pay values increase with the length of a day's activity, application of the value figures for shorter wildlife user days to the 12-hour Forest Service RVD will understate the total value of the resources. There was no way to make an intelligent or meaningful adjustment, though. While some of the wildlife user days reported in the 1975 Survey were undoubtedly shorter than 12 hours, others reported involved overnight stays with days longer than 12 hours and concomitantly higher costs. The assumption had to be made that the two would tend to balance out, and therefore the overall total would not be significantly distorted.

In spite of the significant problems encountered in putting together a report from existing methodologies and data, it is felt that the magnitudes of the results are realistic. Further refinement, both theoretical and empirical, is expected and welcome. But this first approximation should prove to be useful in helping to establish the Intermountain Region's fish and wildlife as major and valuable resources in the National Forest system.

APPENDIX

Critical Choices

Before a rational choice can be made among possible valuation methodologies for fish and wildlife resources, a number of conscious choices must be made so that the analyst knows in advance just what he or she wants to measure, what will actually be measured, and what use the results will have at the outcome. These choices and some of their ramifications are discussed below.

The Problem of Value

Value-in-use. The first decision one must make when adopting a benefits valuation methodology concerns the definition of "value." Economic value may take two forms -- value-in-use, or value-in-exchange. Value-in-use is measured by the total utility or satisfaction one receives from using or consuming some good or service. (Future references to goods will include services by implication.) The dollar valuation attached to this satisfaction received is determined by what the consumer would be willing and able to give up in terms of other goods and services in order to attain that satisfaction.[1] The amount the consumer is willing to give up (which can be measured in dollars) is the dollar value of the total satisfaction attained, or the dollar value-in-use.

Value-in-exchange. Value-in-exchange is measured by what the consumer is required to give up in terms of other goods and services (which can be measured in dollars) in order to purchase the good or service in question. This is essentially the concept of the market price. The value-in-exchange of a loaf of bread is, say, 70¢. One has to give up 70¢ worth of something else to get a loaf of bread. As Schuster (1974) points out, the real value-in-exchange must also include the relaged costs of acquisition. If one has to drive to the store for a loaf of bread, one also pays for the transportation to get the bread. If one takes time off from work to go to the store, the cost of acquiring that bread rises by the cost of the time involved.

Diminishing marginal utility. Economists generally agree that the utility or satisfaction derived from the consumption of units of a good declines as more units of the good are consumed. Therefore, the more of a good one consumes, the less satisfaction an additional unit will provide. Since value-in-use measures how much satisfaction a person receives from consuming a good, declining marginal utility or satisfaction means that one's willingness to pay falls for each additional unit one consumes. Therefore, value-in-use for additional units of a good will fall as more units are consumed. At some point, the additional value-in-use will fall to the level of the actual price per unit (acquisition cost) of the good. Here, value-in-use of the last unit consumed will equal value-in-exchange. Prior to reaching this point, the consumer would be willing to pay, if necessary, some additional amount over and above the price in order to consume that unit. Where value-in-use becomes equal to value-in-exchange, there is no such additional willingness to pay for that last unit consumed. Beyond this point, the "rational" consumer would not purchase any more units, for an additional unit would cost more than the value of the additional satisfaction returned.

[1] The entire discussion of demand and willingness to pay assumes a given distribution of wealth. Every consumer is constrained in total demands by his or her income and other liquid assets.

These relationships can be summarized by means of a simple demand schedule graph (Figure 1.) The value-in-exchange of this good is represented by P, or the price. (It is assumed that P includes all acquisition costs.) The demand schedule DD' represents the total amount the consumer would be willing to pay to consume each additional unit of a good. For instance, the consumer would be willing to pay P plus an additional amount equal to PR in order to consume the first unit. Since the second unit would yield less satisfaction than the first, he or she would only be willing to pay P plus an additional amount PS for that second unit. All other things remaining equal, the total willingness to pay (value-in-use) declines as more units are consumed. To consume a ninth unit, the consumer would be willing to pay only P plus PT. For the tenth unit, value-in-use equals value-in-exchange; there is no additional willingness to pay above P. To purchase an eleventh unit would cost more than the consumer's total willingness to pay. Assuming he or she realized this, that person would not buy the eleventh or additional units.

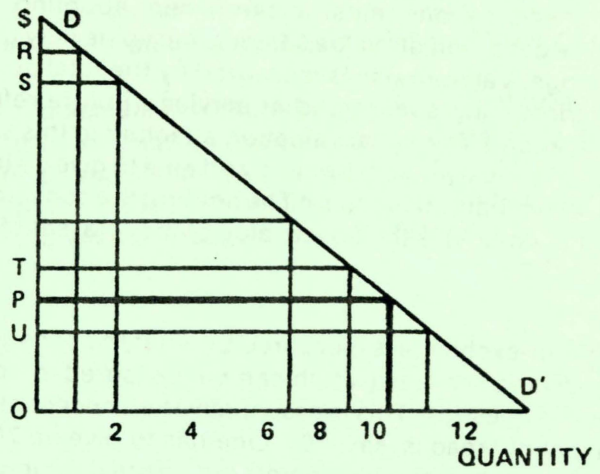

FIGURE 1

Consumer's surplus. In reality, consumers are not generally required to pay for goods and services on a declining scale, according to their value-in-use. If consumers did have to pay in such a fashion, a money value equal to the total value-in-use of that good would have to be paid. The construct of the "perfectly discriminating monopolist" is one method used to show how that total willingness to pay could be exacted from the consumer. The perfectly discriminating monopolist would be in a position to change the price for each additional unit sold to just match the consumer's total willingness to pay for that additional unit. Thus, the consumer would have to pay his or her total value-in-use.

Since consumers generally pay only a set price for all units of a good that they purchase, they receive value-in-use over and above the total value-in-exchange (price times quantity) which they pay. This additional value received is called "consumer's surplus."

In Figure 2, the total value-in-exchange of the good is OPAQ. Total additional (net) willingness to pay, or consumer's surplus, is PDA. Total willingness to pay (acquisition cost, or price, plus consumer's surplus) is shown by the area under the demand curve up to Q, or area ODAQ.

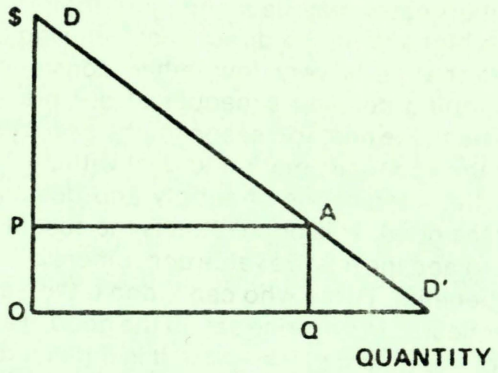

FIGURE 2

Figure 2 illustrates why the choice of the type of value to be used as a measure of the economic value of a good can have a significant impact on its magnitude. Under the hypothetical relationships depicted in the graph, consumer's surplus is almost fifteen percent larger than total value-in-exchange (price times quantity). Total willingness to pay, or total value-in-use, is more than twice as large as total value-in-exchange. Therefore, the choice of a measure of value can greatly influence the magnitude of the results that are derived.

The relationship of total value-in-exchange to consumer s surplus or to total willingness to pay will change as the cost of acquisition (P) changes. Assuming DD' remains unchanged, as P rises consumer's surplus gets smaller and smaller, while total value-in-exchange increases in proportion to consumer's surplus. Also, as P rises, total value-in-use gets smaller as less of the good is used, and total value-in-exchange becomes a greater and greater proportion of total value-in-use. If P falls, the relationships change in the other direction.

The changing proportions between value-in-exchange and value-in-use can be affected significantly by the shape of the demand schedule. As shown in Figure 3, a steeply sloping demand curve, representing low response by consumers to changes in price, will result in a much larger consumer's surplus than will a relatively flat demand schedule. The latter represents high response by consumers to changes in price. As the slope of the demand schdule flattens out, consumer's surplus gets smaller, and the total value-in-use and the total value-in-exchange converge.

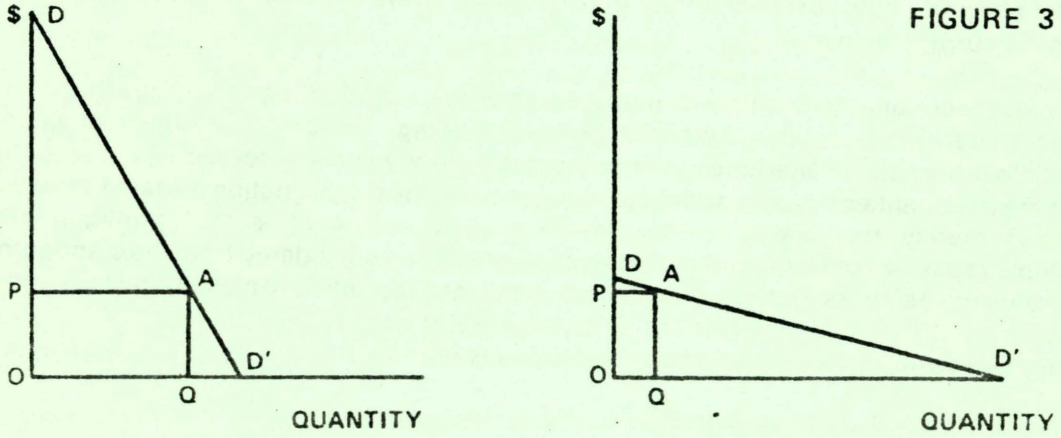

FIGURE 3

Market failure. Fish and wildlife resources on public lands traditionally have had a near-zero price, or value-in-exchange, for the resources themselves. The only direct cost of use has been a license fee. Acquisition costs may be significant, though, so that the real value-in-exchange is generally much higher than the direct cost for using the resource. With a near-zero price, total value-in-exchange is very low, while consumer's surplus is very large (assuming the downward-sloping demand schedule of our previous examples.) Ignoring acquisition costs for the moment, the primary reason for the near-zero price of fish and wildlife resources is the inability of the economic market to deal with public goods such as fish and wildlife. For private goods, the interactions of supply and demand (or some monopolistic forces) act to set a price for the good. This price reflects the cost of the resources which have gone into producing the good and the relative value consumers place on the good. Those who can pay the price enjoy its benefits. Those who can't, don't. With a public good, the costs of supply are not necessarily reflected in the price set on the good, if any price is set at all. Part of the reason is that because of the nature of the good, it is difficult to exclude those who don't pay from enjoying the benefits of the good. Game hunters and anglers have to pay some arbitrarily-set license fee in order to harvest an animal or fish, but everyone else can receive some value or satisfaction from non-consumptive use of wildlife or fish without paying for it.

One of the major missing elements in the price of fish and wildlife resources is a return paid for use of the land on which the resources are based. The land and related resources (habitat) are the primary inputs to wildlife populations. Yet, because of the economic market imperfections and the nature of wildlife as a public good, no land rent (payment to the land resource) is included in the "price" of wildlife resources. In contrast, for instance, farmers growing crops or raising livestock include as one of their costs of production some value (rent) paid for the user land. This cost is reflected in the market price of their products. (If market price is not high enough to cover these costs, the farmer goes out of business. The land will revert to some other use for which it will receive a payment in return that is more in line with its contribution to production.)

Arguments for using total willingness to pay. There are two major reasons for using total willingness to pay, or value-in-use, as the appropriate measure of the economic value of fish and wildlife resources. If land rent were included in the price of these resources, in addition to all other acquisition costs, the total value-in-exchange would increase while consumer's surplus dropped; i.e., more of the total value-in-use would be captured. Adopting value-in-use as our measure helps to compensate for that part of willingness to pay that should be included in the value-in-exchange portion, but which is not because of market and pricing breakdowns. If the pricing mechanism worked the same for social goods as it does for private goods, land rent would be part of the cost paid for use of fish and wildlife resources, rather than part of the consumer's surplus enjoyed.

Second, most economists dealing with public expenditures and public goods argue that when investment alternatives concerning public goods are being considered, the relevant values gained or lost from those alternatives are not just the money costs or revenues, but also the value of the externalities brought about by those goods.[2] Thus, a distinction is drawn between social and merely financial economic analyses. The argument is that public goods investments (dams, wildlife, national defense, etc.) need to be considered from the standpoint of their value to society as a whole, in order to achieve the most efficient allocation of society's

[2]See, for example, Haveman and Margolis, eds. (1970), or Musgrave and Musgrave (1973).

resources. All of the externalities (benefits and costs occurring, but not included in the financial cost of the investment or project) should be internalized: that is, they should be quantified as much as possible and included in the analysis. Benefits and costs not quantifiable should be treated in some descriptive form. Since wildlife is a public good, the analysis of its economic costs and benefits should follow the practice applied to other public goods. All values, positive or negative, resulting from wildlife and wildlife-related projects, should be included. Therefore, the total value-in-use, or willingness to pay, should be included in valuation of fish and wildlife resources. This is the value of these resources to society. That value would be foregone if the wildlife resources were lost.

Arguments against using total willingness to pay. When arguing against using total willingness to pay as a measure of value, one can point out that no other goods are bought and sold according to their consumer's surplus. Why should wildlife be any different? This is a valid point and can not be answered easily. In fact, there is a subargument involved that questions the very existence of such a measure as consumer's surplus. However, it does appear empirically that some people are willing to pay more for a good than are others. If the price is lower, those people willing to pay more apparently receive "bonus" satisfaction over what they pay. Yet the question remains, why aren't the values of other goods measured by total willingness to pay? The most plausible response is that other goods may not provide much consumer's surplus, particularly those goods with which we are concerned in relation to trade-offs with wildlife. For instance, timber is sold on a bid basis for blocks of stumpage. The sale goes to the highest bidder. If it is assumed that the bids made represent the maximum willingness to pay for that timber by each bidder, by accepting the highest bid the total willingness to pay has been extracted for that block of timber. Also, as was seen in Figure 3, if the demand curve for a good is relatively flat, there will be little difference between value-in-use and value-in-exchange. So there may not be such a discrepancy for comparative purposes in using total willingness to pay as one might first think.

Finally, a major argument of those who advocate use of consumer's surplus as the proper measure of value is that only net willingness to pay or consumer's surplus, i.e., willingness to pay over and above the cost of acquisition, should be used as a value measure. The argument is that if people don't spend their money on wildlife recreation, they will spend it on the next best alternative. Therefore, that amount of satisfaction represented by actual expenditures will be derived from some substitute source.

This argument has strong validity on theoretical economic grounds. The real value of the resource by itself would be the unique addition to peoples' satisfactions that would not occur without wildlife. This uniqueness attributable to the wildlife resource is supposedly represented by all or some part of consumer's surplus. However, the argument loses a lot of validity when it is applied to actual situations. For one thing, most other goods are valued at their money prices, not according to consumer's surplus, as was just discussed. The money spent for timber could conceivable be spent for some other building material (cement, bricks, steel, etc.) from which a similar, but not precisely identical, satisfaction could be derived. If the theoretical argument were followed, we would calculate only that net value of timber derived from its unique qualities. But in reality this is not done. Timber is valued at its total dollar cost, even though some or all of that expenditure could be made for substitutes.

Value summary. The choice of which type of value one will use as a measure -- value-in-use or

value-in-exchange -- is a critical one for any valuation procedure. The choice that is made affects the methodological approach, the magnitude of the values that will be derived, and their usefulness for comparing tradeoffs and alternatives.

Value-in-use, or total willingness to pay, was chosen for use in this report for several of the reasons discussed. First, because the market and pricing mechanisms do not work with public goods such as wildlife, using cost of acquisition (value-in-exchange) as a measure of wildlife value would understate the value of the resource to the extent that people are not having to pay any return to the land resource, or rent. Some part of total willingness to pay reflects rent which is not charged because of market failure.

Second, total willingness to pay includes external benefits that should be considered when analyzing problems and projects involving public goods in order to achieve social economic efficiency.

Third, total willingness to pay is more useful as a valuation for comparative purposes than is net willingness to pay, or consumer's surplus. Valuations of other goods and services are not generally made on a consumer's surplus basis.

By using total willingness to pay, or value-in-use, the measure has been chosen that will undoubtedly reflect the highest valuation figures of any method (other than willingness to sell, which has not been discussed here). Cost of acquisition (expenditures) figures will almost never be as great as total willingness to pay figures. Consumer's surplus figures will also be smaller than total willingness to pay. The total willingness to pay figures can be considered to be near some upper bound. But for the reasons discussed -- market failure, social economic efficiency, and usefulness -- it is felt that the approach is defensible until something better is developed.

The Problem of Measure

A decision must be made whether or not to use a "total" or a "net" measure of value. This is a choice that must be made if one decides to use some type of consumer's surplus measure. As was discussed, using consumer's surplus alone will measure to some degree the unique value contributed by a good. The consumer's surplus value will be lower than total willingness to pay (Figure 2). There are practical problems with making a consumer's surplus value comparable with other values for purposes of analyzing trade-offs. The desired use of the output values will be a critical criterion for making this choice.

The Problem of Usability

A major criterion of choice for a valuation methodology is the end use desired for the resulting values. This has already been alluded to in some of the previous discussion. If an agency has defined outputs of wildlife programs in terms of recreation days, the value of those recreation days is what the agency needs to know. Whether that definition of output is the most desirable is a matter always subject to question, of course. But that decision is external to the process of

making these critical choices. The analyst can provide input as to his or her ideas of the proper output to measure. but once that decision is made the valuation efforts should be directed toward the defined output. To measure the value of recreation days when the agency has set up acres of habitat as its goal is an interesting excercise, but it is not very useful for operational purposes.

From an economic standpoint, consideration must be given to the analytical use of the value study. A study such as this one that attempts to set forth a static picture of total current value-in-use needs to include fixed costs as well as variable costs as part of the costs of acquisition. However, if an analysis is being done to determine marginal values and tradeoffs that may occur because of the addition or deletion of a particular project, it would be appropriate to use only variable costs. From the marginal decision-making standpoint, fixed costs are sunk costs. Only the extra costs to be incurred will affect the marginal decision. Predictive-type analyses would want to value an extra day of recreation using only those factors (expected variable costs) affecting the recreationist's decision-making process.

For this study, the choice was made to measure the value-in-use of the recreation day "package" (Clawson, 1959). From a public agency standpoint, the outputs of the various resources managed are those that are desired by society (Schuster, 1974). The social output of wildlife resources, as defined by the Forest Service, is the recreation visitor day (RVD). RVD's are used as targets for both the program-budget process and for RPA purposes. To attempt to measure the value of the wildlife resource itself would be attempting to derive a value for the part of the wildlife recreation day package that is currently non-priced. The wildlife resource is one ingredient among several that actually make up the total recreation day package. It definitely adds a value to the RVD, but it is neither necessary nor useful at this point to define that specific value. (I would emphasize, though, that the specific value of the wildlife resource might well be of great interest and use in some other context. The whole choice of methodology could change if that were the case, as some of the critical decisions discussed here might be different.) The total willingness to pay, or value-in-use, for a recreation visitor day, including all costs of acquisition, will be most useful, in as much as the current study seeks some total value for the wildlife resources' social output. It is not a study examining marginal behavior or making predictions of future consumer behavior.

The Problem of Comparability

Finally, recognition must be given to alternative values with which the study values will be compared. If alternative resource uses are priced at market cost or cost of acquisition, with no consumer's surplus or willingness to pay measured, a similar measure of the resource in question will be most comparable when analyzing resource tradeoffs. For instance, earlier it was argued that timber sold from National Forest lands is valued according to total willingness to pay, including all monetary costs of acquisition. Minerals, through the leasing process, are probably valued in similar terms. When valuing wildlife resources, the wildlife-related consumer's surplus will not estimate the same full range of values-in-use by which the alternative resource values are being calculated. On the other hand, if consumer's surplus valuations have been made for the alternative sets of resources, using total willingness to pay values for the resource under consideration would certainly inhibit effective comparisons with values used for timber, minerals, and other resources on National Forest lands.

Critical Choices Summary

The problems of value, measure, usability, and comparibility are ones that have to be specifically recognized and considered when choosing and appropriate valuation methodology. An explicit choice should be made at each juncture, with the options and ramifications specified. Following this procedure, the choice was made to use total willingness to pay for recreation visitor days of various types of wildlife use as the measure for the economic value of the fish and wildlife resources in the Intermountain Region.

SELECTED REFERENCES

Ashton, P. M., R. A. Wykstra, and K. C. Nobe. 1974. Optimum supplies of recreation days under conditions of uncertainty: a case study application to wildlife resources. Dept. of Economics, Colorado State University, Fort Collins. 93pp.

Beardsley, W. 1970. Economic value of recreation benefits determined by three methods. USDA Forest Service Research Note RM-176. Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO. 4pp.

Beardsley, W. 1971. Bias and noncomparability in recreation evaluation models. Land Economics, 47: 175-180.

Brookshire, D. S., L. S. Eubanks, and R. D. Rowe. 1977. The impact of coal development on wildlife: an economic analysis. Paper prepared for 5th National Conference on Energy and the Environment, Cincinnati, OH, November 3, 1977. Mimeo. 7pp.

Brown, W. G. and F. Nawas. 1973. Impact of aggregation on the estimation of outdoor recreation demand functions. American Journal of Agricultural Economics, 55: 246-249.

Brown, W. G., F. Nawas, and J. B. Stevens. 1973. The Oregon big game resource: an economic evaluation. Special Report No. 379. Agricultural Experiment Station, Oregon State University, Corvallis. 110pp.

Brown, W. G., A. Singh, and E. N. Castle. 1965. Net economic value of the Oregon salmon-steelhead sport fishery. Journal of Wildlife Management, 29: 66-79.

Burt, O. and D. Brewer. 1971. Estimation of net social benefits from outdoor recreation. Econometrica, 39: 813-827.

Canadian Dept. of Fisheries. 1965. A symposium on the economic aspects of sport fishing. Dept. of Fisheries Report No. 4, Ottawa. 147pp.

Clawson, M. 1959. Methods of measuring the demand for and value of outdoor recreation. Resources for the Future Reprint No. 10. Washington, DC. 36pp.

Clawson, M. and J. L. Knetsch. 1966. Economics of Outdoor Recreation. Baltimore: Johns Hopkins University Press.

Davis, B. 1977. Evaluation of Round-Up Fire. USDA Forest Service, Region 4, Dixie National Forest. Internal report.

Davis, R. K. 1964. The value of big game hunting in a private forest. In Transactions of the 29th North American Wildlife and Natural Resources Conference, J. B. Trefethen, ed., pp. 393-403. Washington, DC: Wildlife Management Institute.

Davis, R. K. and J. J. Seneca. 1972. Models for supply and demand analysis in state fish and game planning. In Transactions of the 37th North American Wildlife and Natural Resources Conference, J. B. Trefethen, ed., pp. 234-246. Washington, DC: Wildlife Management Institute.

Doll, G. F. oand C. Phillips. 1972. Wyoming's hunting and fishing resources, 1970. Report prepared for the Wyoming Game and Fish Commission. Division of Business and Economic Research, College of Commerce and Industry, University of Wyoming, Laramie. 116pp.

Edwards, J. A., K. C. Gibbs, L. J. Guedry, and H. H. Stoevener. 1976. The demand for non-unique outdoor recreational services: methodological issues. Technical Bulletin No. 133. Agricultural Experiment Station, Oregon State University, Corvallis. 60pp.

Environmental Research Group. 1974. Southeastern economic survey of wildlife recreation: detailed analysis. Georgia State University, Atlanta.

Environmental Research Group. 1974. Southeastern economic survey of wildlife recreation: executive summary. Georgia State University, Atlanta.

Everest, F. H. 1973. An economic evaluation of anadromous fishery resources of the Siskiyou National Forest. Mimeo. 16pp.

Everest, F. H. 1974. A method of estimating the value of streamside reserve trees. USDA Forest Service, Siskiyou National Forest, Grants Pass, OR. Mimeo. 13pp.

Garrett, J. R., G. J. Pon, and D. J. Arosteguy. 1970. Economics of big game resource use in Nevada. Agricultural Experiment Station, Max C. Fleischmann College of Agriculture, University of Nevada, Reno. 22pp.

Goldstein, J. 1971. Competition for Wetlands in the Midwest and Economic Analysis. Baltimore: Johns Hopkins University Press.

Gordon, D., D. W. Chapman, and T. C. Bjornn. 1973. Economic evaluations of sport fisheries -- what do they mean? In Transactions of the American Fisheries Society, 102: 293-311.

Gum, R. L. and W. E. Martin. 1975. Problems and solutions in estimating the demand for and value of rural outdoor recreation. American Journal of Agricultural Economics, 57: 558-566.

Gum, R. L., W. E. Martin, A. H. Smith, and C. D. Depping. 1973. Participation and expenditures for hunting, fishing, and general rural outdoor recreation in Arizona. Research Report No. 270. Arizona Agricultural Experiment Station, University of Arizona, Tucson. 27pp.

Hammack, J. and G. M. Brown, Jr. 1974. Waterfowl and Wetlands: Toward Bioeconomic Analysis. Baltimore: Johns Hopkins University Press.

Hansen, C. S. 1977. Social costs of Michigan's deer habitat improvement program. Ph. D. Dissertation. University of Michigan, Ann Arbor. 188pp.

Haveman, R. J. and J. Margolis, eds. 1970. Public Expenditures and Policy Analysis. Chicago: Markham Publishing Co.

Henderson, H. 1975. Limitations of traditional economics in making resource decisions. In Transactions of the 40th North American Wildlife and Natural Resources Conference, K. Sabol, ed., pp. 393-404. Washington, DC: Wildlife Management Institute.

Idaho Cooperative Fishery Unit. 1973. Sport fishery economics. Final report to the National Marine Fisheries Service on workshops on fishery economics held at Moscow, ID, and Madison, WI. contract NO. N208-0350-72. University of Idaho, Moscow. 100pp.

Krutilla, J. V. and A. C. Fisher. 1975. The Economics of Natural Environments. Baltimore: Johns Hopkins University Press.

Kunkel, C. and P. Janik. 1976. An economic evaluation of salmonid fisheries attributable to Siuslaw National Forest. USDA Forest Service, Pacific Northwest Region, Siuslaw National Forest. 22pp.

Lancaster, K. 1966. A new approach to consumer theory. Journal of Political Economy. 74: 132-157.

Lundgren, A. L. 1974. Economic bases for allocating resources in outdoor recreation. In Outdoor Recreation Research: Applying the Results, USDA Forest Service, pp. 7-13. General Technical Report NC-9. North Central Forest and Range Experiment Station, St. Paul, MN.

Martin, W. E., R. L. Gum, and A. H. Smith. 1974. The demand for and value of hunting, fishing, and general rural outdoor recreation in Arizona Agricultural Experiment Station. University of Arizona, Tucson. 55pp.

Mathews, S. B. and G. M. Brown. 1970. Economic evaluation of the 1967 sport salmon fisheries of Washington. Technical Report No. 2. Washington Dept. of Fisheries, Olympia.

Meyer, P. A. 1974. A comparison of direct questioning methods for obtaining dollar values for public recreation and preservation. Technical Report Series 110. PAC 17-75-6. Environment Canada, Vancouver.

Michalson, E. L. 1973. Report of recreational and sociological characteristics of hunters and an estimate of the demand for hunting in the Sawtooth Area of Idaho. Water Resources Research Institute, University of Idaho, Moscow. 77pp.

Musgrave, R. A. and P. B. Musgrave. 1973. Public Finance in Theory and Practice. New York. McGraw-Hill.

Nobe, K. C. 1973. The economics of wildlife management. Colorado Outdoors, 22: 28-34/

Norman, R. L., L. A. Roper, P. D. Olson, and R. L. Evans. 1976. Using wildlife values in benefit/cost analysis and mitigation of wildlife losses. colorado Division of Wildlife, Denver. 18pp.

Oliver, W. H. 1967. Economic evaluation of game ranges. Applied Research Division, Washington Game Dept., Olympia. 29pp.

Oliver, W., C. Young, and D. Eldred. 1975. A short form for bioeconomic evaluations of wildlife in Washington State. Washington Dept. of Game Bulletin No. 7. Olympia. 14pp.

Payne, B. R. and R. M. DeGraaf. 1975. Economic values and recreational trends associated with human enjoyment of nongame birds. Paper presented at the Symposium on Management of Forest and Range Habitats for Non-game Birds. Tucson, AZ. 5pp.

Pearse, P. H. and G. Bowden. 1968. Economic evaluation of wildlife development projects through benefit-cost analysis. In Transactions of the 32nd Federal-Provincial Wildlife Conference, pp. 52-64. Dept. of Indian Affairs and Northern Development, Canadian Wildlife Service, Ottawa.

Phillips, C. and S. E. Ferguson. 1977. Hunting and fishing expenditure values and participation preferences in Wyoming, 1975. Prepared for the Wyoming Game and Fish Dept. by the Water Resources Research Institute, University of Wyoming, Laramie. 184pp.

Randall, A., B. Ives, and C. Eastman. 1974. Bidding games for valuation of aesthetic environmental improvements. Journal of Environmental Economics and Management, 1: 132-149.

Richards, J. 1969. An economic evaluation of Columbia River anadromous fish programs. Working Paper No. 17. Bureau of commercial Fisheries, Div. of Economic Research. 274pp.

Rohdy, D. D. and R. E. Lovegrove. 1970. Economic impact of hunting and fishing expenditures in Grand County, Colorado, 1968. Colorado Division of Fish, Game, and Parks in cooperation with Dept. of Economics, Colorado State University, Fort Collins. 83pp.

Ross, L. A., D. M. Blood, and K. C. Nobe. 1975. A survey of sportsmen expenditures for hunting and fishing in Colorado, 1973. Contract report for the Colorado Division of Wildlife. Dept. of Economics, Colorado State University, Fort Collins. 102pp.

Schuster, E. G. 1977. Investment analysis: problems and prospects in recreation, wildlife, and fishery management. In Outdoor Recreation: Advances in Application of Economics, USDA Forest Service, pp. 133-139. General Technical Report WO-2. Washington, DC. 163pp.

Scott, A. 1965. The valuation of game resources: some theoretical aspects. Canadian Fisheries Reports, 4: 27-47.

Sheridan, W. L. 1969. Benefit/cost aspects of salmon habitat improvement in the Alaska Region. USDA Forest Service, Branch of Wildlife Management, Region 10, Juneau. 47pp.

Tuttle, M. 1971. Fish and wildlife economics. In Proceedings of Fish and Wildlife Habitat Management Training Conference, USDA Forest Service, pp. 1-7. Pacific Northwest Region, Portland.

Tuttle, M., J. Richards, and R. Wahle. 1975. Partial net economic values for salmon and steelhead for the Columbia River system. U. S. Dept. of Commerce, NOAA, National Marine Fisheries Service. 22pp.

U. S. Dept. of Agriculture, Forest Service. 1975. RPA supplemental appendix. Washington, DC. 100pp.

U. S. Dept. of Agriculture, Forest Service, 1977. Outdoor recreation: advances in application of economics. Proceedings of a national symposium held in New Orleans, November, 1974. General Technical Report WO-2. Washington, DC. 163pp.

U. S. Dept. of Agriculture, Forest Service. 1977. Recreation information management (RIM) system reports, 1976. Intermountain Region, Ogden, UT. Microfilm.

U. S. Dept. of Interior, Fish and Wildlife Service. 1972. National survey of fishing and hunting, 1970. Resource Publication 95. Washington, DC. U. S. Government Printing Office. 108pp.

U. S. Dept. Of Interior, Fish and Wildlife Service. 1977. 1975 national survey of hunting, fishing, and wildlife-associated recreation. Technical reports for Idaho, Utah, Nevada, and Wyoming. Washington, DC.

Wennegren, E. B. 1967. Demand estimates and resource values for resident deer hunting in Utah. Bulletin 469. Agricultural Experiment Station, Utah State University, Logan, UT. 44pp.

Westman, W. E. and W. D. Conn. 1976. Quantifying benefits of pollution control: benefits of controlling air and water pollution from

energy production and use. A report to the California Energy Resources Conservation and Development Commission University of California at Los Angeles, Los Angeles 419pp

Wilcox, S. W. 1972. Deer production in the United States: a survey by states showing the dollar value of deer as table meat in the years 1969 and 1970. Arizona State University, Tempe. Mimeo. 4pp.

Wilson, L. and D. Waite. 1972. Wildlife values on public lands, an economic dilemma. Paper presented to the Economics Coordination Conference. Reno, NV. Mimeo. 10pp.

A D D E N D U M T O

A REPORT ON THE VALUE OF WILDLIFE
(Wildlife Economics)

Prepared for the

INTERMOUNTAIN REGION

FOREST SERVICE

by

Christopher S. Hansen

March 1, 1979

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P U R P O S E

The purpose of this addendum is to update the original report, which was based on 1976 data and used 1975 as the current dollar base. Four major changes are incorporated into the report by this addendum:

1. Recreation visitor-day data for 1978 are used.

2. All dollar values are inflated from 1975 to 1978 dollars in order to keep them in current perspective.

3. The California portion of Region 4 lands are shown separate from Nevada.

4. Additional analysis is included to estimate both on-site and off-site sport and commercial values of anadromous fish produced on National Forest lands.

METHODOLOGY

The methodology for the original report, with its accompanying assumptions, is retained. Additional work, with a somewhat different approach, was required to account for off-site sport and commercial anadromous fish values. It is felt that total willingness to pay (actual expenditures plus estimated consumer surplus) remains a valid means for estimating the total annual value of the fish and wildlife resources on National Forest lands in the Intermountain Region.

RESULTS

State-specific and regional composite wildlife user day values are shown in Tables A-1 and A-2, updated to 1978 dollars. [1/] The data base for derivation of the user day values remains the same as in the original report.

Wildlife user days on National Forest lands in the Intermountain Region for 1978 are shown in Table A-3. Because RIM data is now reported on a fiscal year basis, the reported use is only through September 30, 1978. Generally, wildlife use shows an overall increase from 1975 to 1978. There are a few exceptions. An increase in use has resulted in an increase in the total value of the Intermountain Region's fish and wildlife resources. Tables A-4 and A-5 reflect both the increase in use (an increase in real value) and the inflationary increase (an increase in monetary value) from 1975 to 1978. The total value of the Region's fish and wildlife resources for 1978 was approximately $125 million, not including off-site sport and commercial anadromous fish values.

Anadromous Fish: The original report included only on-site values of anadromous fish in the Region, as reflected through recreation visitor days on National Forest lands. These on-site values have increased substantially since 1975. At that time there was very little fishing activity because of low runs and restricted or closed seasons. In 1978, runs had improved sufficiently to allow increased opportunity for taking anadromous fish. The results are reflected in increased user days (Table A-3) and higher total dollar values (Tables A-4 and A-5).

1/ The inflation factor for the economy from 1975 to 1978, as indicated by change in the personal consumption expenditures sector of the gross national product, was 13.2% (Economic Report of the President, 1978).

TABLE A-1

WILDLIFE USER DAY UNIT VALUES
(1978 Dollars)

	IDAHO	NEVADA/ CALIFORNIA	UTAH	WYOMING	REGION 4 (Weighted Avgs.)
Big Game Hunting	36.04	77.26	53.70	40.00	44.65
Deer	25.97	82.50	47.40	30.31	
Elk	46.00	21.87	89.37	47.75	
Antelope	22.19	42.26	0.00	15.01	
Other Big Game	48.25	164.14	233.53	73.34	
Small Game Hunting	25.25*	33.18	54.01	16.44	32.61
Upland Bird Hunting	40.03	83.58	28.67	56.60	44.10
Waterfowl Hunting	16.35	54.89	35.04	76.01	33.43
Cold Water Sport Fishing (resident fish)	17.15	28.76	24.03	18.47	21.73
Anadromous (sea-run) Sport fishing**	31.92	--	--	--	31.92
Non-Consumptive Use (observ. expend. only)	1.58	0.80	1.90	1.13	1.43

* Original data adjusted to eliminate one extremely high response.

** On-site values only.
(Source: Table 1, original "Value of Wildlife Report", adjusted to 1978 dollars.)

TABLE A-2

COMPOSITE WILDLIFE USER DAY VALUES
(1978 Dollars)

ACTIVITY	AVERAGE USER DAY VALUE
Big Game Hunting	45
Small Game Hunting	28
Upland Bird Hunting	40
Waterfowl Hunting	34
Cold Water Sport Fishing (resident fish)	23
Anadromous (sea-run) Sport Fishing *	34
Non-Consumptive Use	45

* On-site value only.

(Source: Table 2, original "Value of Wildlife Report", adjusted to 1978 collars.)

TABLE A-3

WILDLIFE USER DAYS ON NATIONAL FOREST LANDS, 1978
(12-Hour Recreation Visitor Days)

	CALIFORNIA	IDAHO	NEVADA	UTAH	WYOMING	REGION 4 (Total)
Big Game Hunting	58,200	339,500	84,700	594,300	150,700	1,227,400
Small Game Hunting	1,900	18,700	11,200	36,700	3,700	72,200
Upland Bird Hunting	2,300	35,000	19,800	42,200	7,500	106,800
Waterfowl Hunting	4,600	13,100	2,100	31,500	7,200	58,500
Cold Water Sport Fishing (Resident fish)	172,400	628,100	92,300	1,035,900	226,800	2,155,500
Anadromous (sea-run) Sport Fishing	--	69,800	--	--	--	69,800
Non-Consumptive Use ("Nature Study")	4,200	21,300	13,000	45,200	11,500	95,200

(Source: U.S. Forest Service RIM Reports, 1978.)

TABLE A-4

TOTAL ECONOMIC VALUE OF WILDLIFE RESOURCES
ON NATIONAL FOREST LANDS USING STATE-SPECIFIC VALUES, 1978
($1,000's)

	CALIFORNIA	IDAHO	NEVADA	UTAH	WYOMING	REGION 4 (Total)
Big Game Hunting	4,497	12,236	6,544	31,914	6,028	61,219
Small Game Hunting	63	472	372	1,982	61	2,950
Upland Bird Hunting	192	1,401	1,655	1,210	425	4,883
Waterfowl Hunting	252	214	115	1,104	547	2,232
TOTAL - ALL HUNTING	5,004	14,323	8,686	36,210	7,061	71,284
Cold Water Sport Fishing (resident fish)	4,958	10,772	2,655	24,893	4,189	47,467
Anadromous (sea-run) Sport fishing *	--	2,228	--	--	--	2,228
TOTAL - COLD WATER FISHING	4,958	13,000	2,655	24,893	4,189	49,695
TOTAL - HUNTING & FISHING	9,962	27,323	11,341	61,103	11,250	120,979
Non-Consumptive Use (composite daily value)	189	959	585	2,034	518	4,285
TOTAL WILDLIFE VALUE	10,151	28,282	11,926	63,137	11,768	125,264

* On-Forest value only.

TABLE A-5

TOTAL ECONOMIC VALUE OF WILDLIFE RESOURCES
ON NATIONAL FOREST LANDS USING COMPOSITE AVERAGE VALUES, 1978
($1,000's)

	CALIFORNIA	IDAHO	NEVADA	UTAH	WYOMING	REGION 4 (Total)
Big Game Hunting	2,619	15,278	3,812	26,743	6,782	55,234
Small Game Hunting	53	524	314	1,028	104	2,023
Upland Bird Hunting	92	1,400	792	1,688	300	4,272
Waterfowl Hunting	156	445	71	1,071	245	1,988
TOTAL - ALL HUNTING	2,920	17,647	4,989	30,530	7,431	63,517
Cold Water Sport Fishing (resident fish)	3,965	14,446	2,123	23,826	5,216	49,576
Anadromous (sea-run) Sport Fishing *	--	2,373	--	--	--	2,373
TOTAL - COLD WATER FISHING	3,965	16,819	2,123	23,826	5,216	51,949
TOTAL - HUNTING & FISHING	6,885	34,466	7,112	54,356	12,647	115,466
Non-Consumptive Use	189	959	585	2,034	518	4,285
TOTAL WILDLIFE VALUE	7,074	35,425	7,697	56,390	13,165	119,751

* On-Forest value only.

The approach taken in the original report for valuation of the anadromous fish resource produced on National Forest lands underestimates the total value of those fish produced, as it does not account for sport and commercial fishing values derived from these fish downstream on the lower Snake River, in the Columbia River, or in the ocean. In order to account for these values in this update, the methodological approach used by Tuttle et al. (1975) was applied to the anadromous fish of the Snake and Salmon Rivers.2/

Total estimated on-site and off-site values for sport and commercial fishing provided by anadromous fish produced on National Forest lands in the Intermountain Region are shown in Table A-6. Part of these values might be attributable to the Northern Region (which lies on the northside of the Salmon River up to the boundary of the Salmon National Forest), but most of the spawning reaches are in the Intermountain Region.

Use of this alternate methodology for valuing anadromous fisheries, rather than showing just the on-site values as in Table A-4, results in a total value of fish and wildlife resources of approximately $131 million for the Intermountain Region. These revised results are displayed in Table A-7.

Deer Habitat Improvement: Using the same assumptions as in the original report, deer habitat improvement work would be worth $104 and $27 per acre respectively.

2/ The reader is referred to the Tuttle report for a detailed description of the methodology and its application. Also, see the Appendix for a discussion of how the methodology was utilized for this report.

CONCLUSION

A caution is again in order regarding the use of the values in this report. Values of incremental (marginal) changes in available fish and wildlife habitat will probably be lower than the overall averages used here. Using these values without an evaluation of the individual project under consideration could lead to an overstatement of either gains or losses expected. Specific values for project work are dependent on the type of habitat change, the species benefited, the magnitude of the project, and the relative demand people have for the consumptive or nonconsumptive use of that/those species. However, the values shown here can serve as a guide and provide a scale of magnitude.

TABLE A-6

ANADROMOUS FISH RESOURCE VALUES
(On-Site and Off-Site Sport and Commercial Fishing Values)

FISHERY	1978 ESCAPEMENT (Numbers of fish)	VALUE PER ESCAPED FISH (1978 dollars)	TOTAL VALUE (1978 dollars)
Spring Chinook	17,200	209	3,594,800
Summer Chinook	8,475	209	1,771,275
Fall Chinook	1,350	143	193,050
Summer Steelhead	9,700 *	223	2,163,100
		REGION TOTAL	7,722,225

*Fall '77-Spring '78 run

(Source: Escapement figures from Idaho Department of Fish and Game.
See text and Appendix for discussion of value derivation.)

TABLE A-7

TOTAL ECONOMIC VALUE OF NATIONAL FOREST WILDLIFE RESOURCES,
INCLUDING OFF-SITE ANADROMOUS FISH VALUES
($1,000's)

	CALIFORNIA	IDAHO	NEVADA	UTAH	WYOMING	REGION 4 (Total)
Big Game Hunting	4,497	12,236	6,544	31,914	6,028	61,219
Small Game Hunting	63	472	372	1,982	61	2,950
Upland Bird Hunting	192	1,401	1,655	1,210	425	4,883
Waterfowl Hunting	252	214	115	1,104	547	2,232
TOTAL - ALL HUNTING	5,004	14,323	8,686	36,210	7,061	71,284
Cold Water Sport Fishing (resident fish)	4,958	10,772	2,655	24,893	4,189	47,467
Anadromous (sea-run) Sport Fishing	--	7,722	--	--	--	7,722
TOTAL-COLD WATER FISHING	4,958	18,494	2,655	24,893	4,189	55,189
TOTAL-HUNTING & FISHING	9,962	32,817	11,341	61,103	11,250	126,473
Non-Consumptive Use	189	959	585	2,034	518	4,285
TOTAL WILDLIFE VALUE	10,151	33,776	11,926	63,137	11,768	130,758

APPENDIX

In order to make the angler day values used by Tuttle et al. (1970) consistent with those in the rest of this report, the original figures from the Mathews and Brown (1972) study were used to develop a total willingness to pay value for an angler day. Since the Mathews and Brown study listed expenditures and net willingness to sell, but not net willingness to pay values, the latter were estimated to be roughly equal to daily expenditures. This assumption was based on the 1975 National Hunting and Fishing Survey, which showed an approximate 1:1 ratio between expenditures and net willingness to pay. The total willingness to pay value was then inflated from 1967 to 1978 values. The resulting value was $42 per angler day.*

Commercial values for pounds of fish were adjusted upward for inflation between 1973 and 1977 by the wholesale price index for "Crude Materials for Further Processing: Foodstuffs and Feedstuffs." The inflation factor was only 6.06% for this category. The resulting values were:

Coho	$1.00/pound
Chinook	$1.05/pound
Steelhead	$0.58/pound

The other figures in the Tuttle methodology (angler days of effort per fish caught, percent distribution of catch, average pounds per fish, and catch:escapement ratio) were retained, pending future revision based on more current data. Calculations of value per escaped anadromous fish were made using escapement figures for the Salmon River and a portion of the Snake River between Asotin and Hells Canyon Dam. These data were supplied by the Idaho Department of Fish and Game.

* This value is higher than the on-site value shown in Tables A-1 and A-2, primarily because ocean anadromous sport-fishing is generally a higher valued activity than anadromous sport-fishing along a river.

Finally, the assumption that there is a rough equality between the angler days used in various studies and the standard Forest Service 12-hour recreation visitor day was retained. This assumption is discussed in the original report.